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Sacred Heart University

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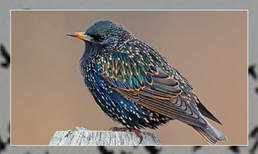
DIETARY FATTY ACID CONTENT & NUEROGENESIS: IDENTIFICATION OF SPECIFIC FATTY ACIDS CORRELATED WITH NUEROGENESIS

Max Trudeau
mentor Dr. Barbara Pierce, PhD
Department of Biology, Sacred Heart University, Fairfield, CT




Abstract

The process of neurogenesis is continuous throughout the life of most mammals, specifically in the vertebrate brain. It also plays a major role in the initial growth of the nervous system. In birds neurons are generated from neural stem cells throughout the telencephalon into adulthood. This neurogenesis can be upregulated by fatty acids and other dietary supplements. Strenuous exercise has also been associated with having a strong effect on neuroproliferation. In European Starlings, HVC, a nucleus involved in learning and production of birdsong, can be used to analyze neuronal recruitment because HVC is associated with song modification that has a resulting growth in volume. This neuron recruitment and neuron migration is significantly influenced by dietary fatty acids. In this study four diet groups were used, each group consisted of 15 individuals who experienced flight training in a wind tunnel and 10 who did not. The four diet groups were defined by two factors, polyunsaturated fatty acid content either high or low (32% vs. 13%), and endogenous antioxidants (high or low). The brain samples of sacrificed birds were then analyzed for fatty acid composition. This consisted of a total lipid extraction from the brain tissue, followed by a separation of the fatty acid classes (neutral and phospholipids; NL & PL), and lastly transesterification of the separated lipids prior to gas chromatographic analysis. Preliminary results suggest that there is a correlation between diet, fatty acid composition of brain tissue, and neural genesis.

Introduction

It is known that fatty acid composition of diet can influence neurogenesis in brain tissue, specific fatty acids like arachidonic acid have been identified to play major roles in brain development, anti-inflammatory activities, memory and neurogenesis (Dinel et al. 2016). Fatty acid composition of diet has been seen to influence composition of various body tissues such as fat, muscle, organs and digestive tissue. It is known that the brain can influence its composition of fatty acids in tissue storage via enzymatic and non-enzymatic conversion of fatty acids (Sun et al. 2017). It is likely that the brain is converting dietary fatty acids in order to satisfy neuronal requirements of specific fatty acids. Few studies have examined the influence of dietary fatty acid composition on the brain tissues composition of fatty acids.

Methods

- 32 European Starlings were captured during fall migration
- The birds were separated and introduced to four different diet groups for approximately four months
- The four diets included: a monounsaturated fatty acid diet with high anti-oxidant levels(MH), and low antioxidant levels(ML), and a polyunsaturated fatty acid diet with high levels of antioxidant(PH), and low levels of antioxidant(PL). Vitamin E was used as the antioxidant.
- Use of these semi-synthetic diets ensured that composition of the diets was less ambiguous than diets composed of raw foodstuffs
- Birds were then sacrificed and fatty composition of NL in brain tissue was determined

Sample Analysis

- Lipids were extracted from approximately 50 mg of avian brain tissue using a modified version of folch et al 1956.
- Lipid extract was washed with 0.88% KCl water solution followed by CH_2Cl_2:methanol:water (3/48/47).
- Lipids were separated into classes (NL and PL) by filtration using Supelclean clean solid phase extraction tube (3 ml LC-NH2 Sigma. St Louis, MO, USA)
- NL lipids in samples were quantified using gas chromatography Shimadzu GC-2010

Hypothesis

It is expected that the fatty acid composition of the brain tissues from the starlings will be reflective of the dietary fatty acid compositions in their semi synthetic diets.

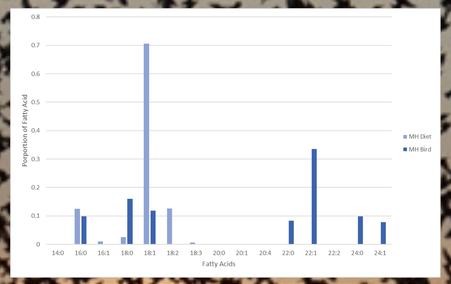


Figure 1. Mean proportions of fatty acid composition in brain tissue for MH group compared to dietary fatty acids.

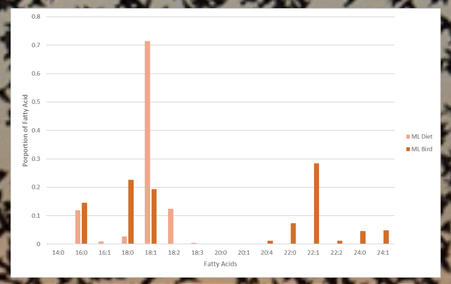


Figure 2. Mean proportions of fatty acid composition in brain tissue for ML group compared to dietary fatty acids.

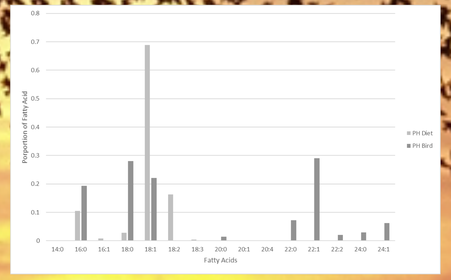


Figure 3. Mean proportions of fatty acid composition in brain tissue for PH group compared to dietary fatty acids.

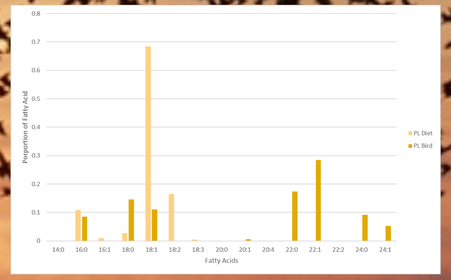


Figure 4. Mean proportions of fatty acid composition in brain tissue for PL group compared to dietary fatty acids.

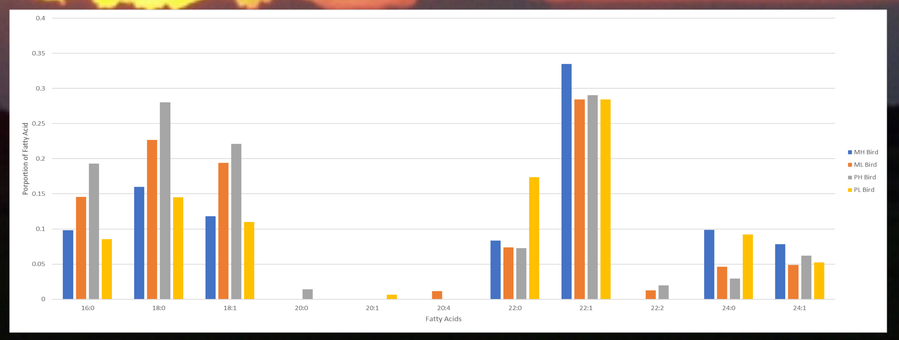


Figure 5. Mean proportions of fatty acid composition in brain tissue fatty of all four groups MH, ML, PH and PL.

Results

- The differences in fatty acid composition between the different groups of birds appear to be relatively similar
- The birds are not storing any amounts of 18:2
- The birds are not storing large amounts of 18:1 even though it is found in the diets
- Birds seem to selectively storing large amounts of longer chain monounsaturated fatty acids

Important Implications

- It was seen that the differences in diets were not significant enough to produce large differences in neutral lipids of the brain
- The birds seem to be utilizing 18:2 immediately which is expected as it is an essential fatty acid of the body
- Large amounts of 18:1 not being stored suggest that the birds may be converting 18:1 into 22:1 and 24:1
- Longer chain monounsaturated fatty acids being stored may be due to the fact that longer chain fatty acids are more easily mobilized and utilized by cells (Pierce et al. 2014)
- Monounsaturated fatty acids have been shown to promote neuronal recruitment (Hall et al. 2014)

Future Directions

- Statistical analysis to determine significance of neutral lipids in brain tissue of four dietary groups
- Quantification and statistical analysis of phospholipids to gain better insight of membrane composition of brain cells

Figure 6. Advanced Facility for Avian Research

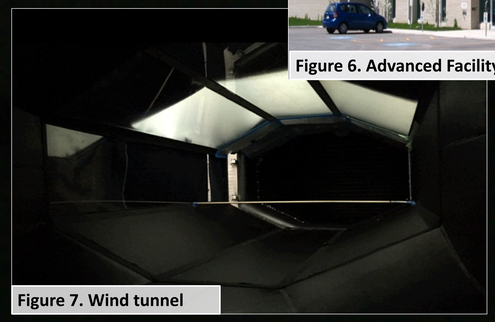
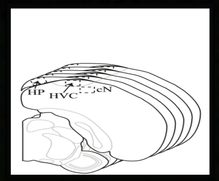


Figure 7. Wind tunnel



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